

ACTION OF SUCCINYLSCHOLINE ON EXTRAOCULAR MUSCLES AND INTRAOCULAR PRESSURE

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SOME physiological actions of succinylcholine have been presented by Lincoff *et al.* (1) including a confirmation of the observation by Hoffmann and Holzer (2) that this drug produces an increase in intraocular pressure in man. The elevation of intraocular pressure in animals under light anesthesia as observed by Lincoff *et al.*, was believed to be due to contracture of the extraocular muscles, since it was noted that in the cat the eyeball tended to rotate in the direction of unsevered extraocular muscles. Hoffmann and Lembeck (3) previously demonstrated that *in vitro* strips of extraocular muscles from the rabbit were put into contracture by both succinylcholine and decamethonium (C-10).

The following data were secured from *in vitro* preparations of extraocular muscles from the cat and from man. Several clinical observations which we believe add further information to the unique action of the depolarizing neuromuscular blocking agents on extraocular muscles are included.

PROCEDURE AND RESULTS

One of the extraocular muscles of a cat was carefully dissected and placed in a constant temperature bath containing 50 ml. of Kreb's solution through which a fine stream of 90 per cent oxygen and 10 per cent carbon dioxide was continuously bubbled. The muscle was allowed to become acclimatized for one hour, after which 10 μ g. of succinylcholine were added. The muscle promptly went into contracture (fig. 1) which was relieved by thorough washing. To demonstrate that succinylcholine was the cause of this type of contracture, a muscle was prepared and blocked with curare. Curare failed to produce any effect upon the extraocular muscle and prevented succinylcholine from producing a significant contracture. After thorough washing, however, succinylcholine again demonstrated its effect upon the preparation (fig. 2). It has been noted on 10 preparations that when small doses of succinylcholine are added at intervals, a step-like phenomenon can be observed insofar as contracture of the muscle is concerned (fig. 3). If a large dose is first administered, however, complete blockade occurs after an initial high tension, and addition of subsequent doses is totally ineffective (fig. 4).

Accepted for publication August 7, 1956. The authors are in the Departments of Surgery (Division of Anesthesia) and Pharmacology, University of California Medical Center, Los Angeles, California. These investigations were aided by grants from the United States Public Health Service and Burroughs Wellcome & Co., Inc.

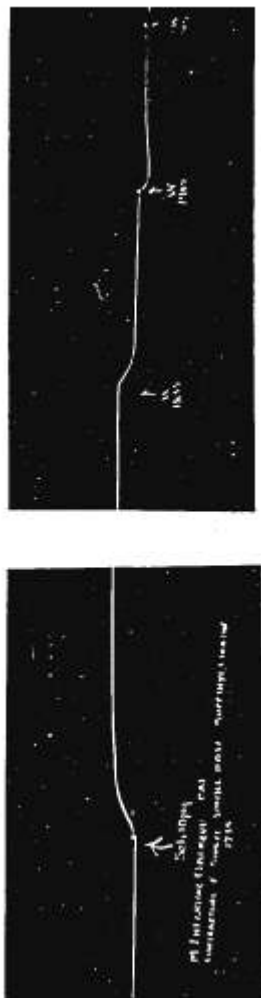


FIG. 1. Contraction of extraocular muscle of cat produced by 10 μ g. of succinylcholine, in vitro.

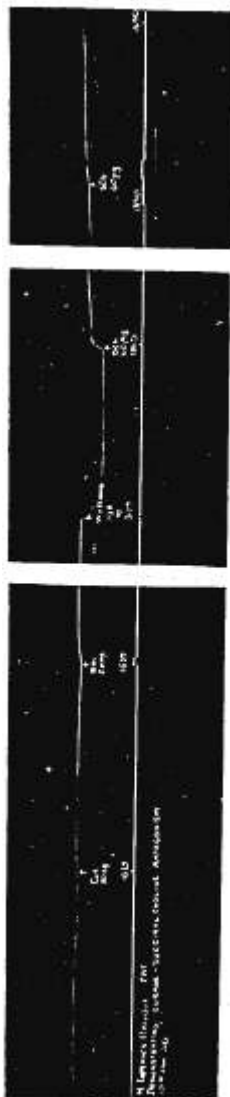


FIG. 2. Action of curare in blocking contraction of extraocular muscle produced by succinylcholine and the effect of succinylcholine in producing contraction after wash.



FIG. 3. Additive effect of succinylcholins in producing contraction of isolated extrocular musculo in cat, in vitro.



FIG. 4. Initial contracture and complete blockade produced by large doses of succinylcholino in isolated extrocular musculo of a cat.



FIG. 5. Contraction produced by 20 μ g. of succinylcholine on isolated human extraocular muscle, *in vitro*.



FIG. 6. Additive effects of 2 doses of succinylcholine in isolated extraocular human muscle, *in vitro*.

It was possible to secure specimens of human extraocular muscles at an operation for an extraorbital tumor. Human muscles demonstrated the same contracture phenomena (fig. 5) when small quantities of succinylcholine were added to the bath that was seen in the preparations of cat muscle. The addition of small doses of succinylcholine to *in vitro* human ocular muscle produced summation, although the demonstration was not quite as clear as in the preparation of the cat muscle, because of the rather marked effect of the relatively small dose of succinylcholine on this particular preparation of human extraocular muscle (fig. 6).

In a further attempt to narrow down the site of action of succinylcholine in its effects upon intraocular pressure, preparations of the constrictor muscle of the iris were made in a manner similar to that of the extraocular muscles. Succinylcholine failed to produce any change in muscle tension in these preparations while the muscles were effectively contracted by small doses of acetylcholine.



FIG. 7. Effect of decamethonium and of succinylcholine on extraocular muscle of cat.

The above data tend to indicate that the elevation of intraocular pressure, seen after the administration of succinylcholine in lightly anesthetized man and animal, is most likely due to the effect of this drug upon extraocular muscle wherein there is uniformly produced a moderate to severe contracture following the administration of this drug to *in vitro* preparations of extraocular muscle of the cat and man. It has been possible *in vitro* in the cat to demonstrate that decamethonium produces contracture of extraocular muscle of the same order as succinylcholine (fig. 7); but in man at operation we have observed that the action of decamethonium is not so pronounced, nor can it be elicited with what would be considered equieffective doses of succinylcholine.

CLINICAL OBSERVATIONS

A 50-year-old white male was brought to surgery for a subtotal gastric resection. An incidental finding was the fact that this man had had an operation performed on his left eye for glaucoma which resulted in the formation of a drainage bleb. The right eye had never demonstrated any increase in tension. This patient was lightly anesthetized with Surital® and nitrous oxide-oxygen and 40 mg. of succinylcholine were administered intravenously. Tonometer readings were made before and after in both eyes, and it was observed that there

was a 10 mm. of Hg increase in tension in the right eye which had never shown any clinical evidence of glaucoma, but in the operated left eye with the drainage bleb, there was no increase in tension. The observation was repeated several times on the same patient with consistent results. This finding would tend to indicate that the duration and type of intraocular pressure rise seen in lightly anesthetized patients is a function of the ability of the aqueous to drain through the canal of Schlemm and that the rate of fall of pressure might be a satisfactory index of the ability of the canal of Schlemm to drain. It is recognized, however, that this might well be a hazardous procedure to undertake in a patient with glaucoma, and it is not recommended.

It has been reported to us by Godman (4) that a small amount of vitreous was lost from the eye of a patient undergoing cataract surgery wherein succinylcholine was administered to the patient under light anesthesia at the time that the sclera had been incised and the anterior chamber opened. It would appear, therefore, that the administration of succinylcholine for intraocular surgery is at least hazardous and possibly contraindicated, since there are other muscle relaxants, particularly curare in the form of *d*-tubocurarine, that will produce muscular relaxation of the extraocular muscles without any increase in tension of the globe. It is highly probable that the use of succinylcholine in any form of ocular surgery is unwise since as Lincoff (1) has pointed out, the eye tends to rotate away from a severed muscle. This phenomena has been noted in recession operations on humans, and while not making the operation impossible, certainly does not facilitate its performance.

SUMMARY AND CONCLUSION

Succinylcholine has been shown to cause contracture of *in vitro* preparations of extraocular muscles of the cat. Succinylcholine will produce similar contracture of the extraocular muscle of the human. The amount of rise of the intraocular pressure seems to be related to the rate of drainage of the aqueous.

The administration of succinylcholine to a patient undergoing intraocular surgery has produced a serious complication.

It is concluded that succinylcholine is probably not the muscle relaxant of choice in ocular surgery, and that it would be preferable to use some other muscle relaxant, specifically curare which produces neither an increase in intraocular pressure nor contracture of extraocular muscles.

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